Differential Diagnostic Pacing Maneuvers of Regular, Narrow QRS Tachycardia.
Background

Clinical characteristics and surface ECG findings are sometimes useful for the differential diagnosis of SVT’s. Invasive electrophysiologic study (EPS) is usually required for a definite diagnosis and treatment of SVT’s: three most common SVT’s, namely AT, ORT (AVRT), and AVNRT. To achieve a definite diagnosis, a lot of pacing maneuvers have been proposed, but an individual application of these have shown limitations of diagnostic yield.

Therefore, here, a comprehensive stepwise approach using entrainment pacing maneuver is proposed for a differential diagnosis of SVT’s.
Simple and single diagnostic EPS findings.

At baseline study, poor retrograde conduction suggests AT, and lesser compatible with ORT (AVRT) or AVNRT.

During ventricular pacing, an eccentric atrial activation with same sequence of that during SVT suggests ORT (AVRT), and lesser compatible with AVNRT.

During ventricular pacing, a concentric atrial activation with an eccentric atrial activation during SVT suggests AT.

A short septal VA interval (<70ms) during SVT usually indicates typical AVNRT (rarely AT, and left-side AP).
Simple and single diagnostic EPS findings.

**VA block during SVT** is uncommon (ventricular rate > atrial rate). ORT (AVRT) and AT are excluded. AVNRT and NV/VF tachycardia should be considered.

**AV block during SVT** never occur during ORT (AVRT) (ventricular rate < atrial rate). AT and AVNRT should be considered.

**PVC during His refractory period**

**Para Hisian pacing**
Ventricular Overdrive Pacing (VOP).

Pacing the ventricle 10 to 40ms shorter than the tachycardia CL to entrain the PSVT.

Three Types of VOP responses:

Entrainment with 1:1 VA conduction
  atrial activation sequence during and after VOP.
Termination of the SVT
  without perturbation of atrial cycle, R/O AT
No affect on PSVT with VA dissociation
  AVNRT or AT, R/O ORT (AVRT)

AOP is useful to differentiate AVNRT/AVRT from AT
Step I. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AT vs. AVRT/AVNRT.

V-A-A-V response: no inclusion of AV node in tachycardia circuit. AT or JT.
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Pseudo V-A-A-V response: The interval between the first and second atrial activation after VOP is exactly as same as PCL. Atypical AVNRT or decremental conducting AP (PJRT).
Step I. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AT vs. AVRT/AVNRT.

True V-A-A-V response in Atypical AVNRT or Decremental AP:
The interval between the first and second atrial activation after VOP is different compared to PCL (double atrial response).
Step I. AOP (Atrial Overdrive Pacing) with entrainment of SVT: AT vs. AVRT/AVNRT.

VA linking: the interval from the last entrained ventricular electrogram to the first atrial electrogram is same as VA interval during SVT. Another pacing maneuver to differentiate AT form AVRT/AVNRT.
Step I. AOP (Atrial Overdrive Pacing) with entrainment of SVT: AT vs. AVRT/AVNRT.

\[ \Delta VA \text{ interval of differential AOP} \]

\( \Delta VA \) is the difference of post-pacing VA intervals acquired from two different sites.

AT (AV node independent): no VA linking, \( \Delta VA \geq 20 \text{ msec} \)

AVNRT/AVRT (AV node dependent): VA linking and \( \Delta VA < 20 \text{ msec} \)
Step II. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AVRT vs. AVNRT.

- PPI-TCL $\geq$ 115 msec, SA-VA $\geq$ 85 msec: AVNRT.
- PPI-TCL=150 $\geq$ 115 msec, SA-VA=120 $\geq$ 85 msec: AVNRT.
Step II. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AVRT vs. AVNRT.


- VPI-TCL ≤ 115 msec, SA-VA ≤ 85 msec: AVRT.
- PPI-TCL=100 ≤ 115 msec, SA-VA=40 ≤ 85 msec: AVRT (ORT).
Step II. VOP (ventricular Overdrive Pacing) with termination of SVT: AVRT vs. AVNRT.

\[
\text{Predicted PPI - TCL} = (\text{NNE} - 1) \times (\text{TCL} - \text{PCL}) - \text{tachycardia advancement}
\]

\[
= (4 - 1) \times (370 \text{ ms} - 340 \text{ ms}) - 20 \text{ ms}
\]

\[
= 70 \text{ ms}
\]

TPP (total pacing prematurity) = just before needed number of entrainment = NNE-1
Step II. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AVRT vs. AVNRT.

**PPI-TCL interval and SA-VA interval.**
- PPI-TCL ≥ 115 msec, SA-VA ≥ 85 msec: AVNRT.
- PPI-TCL ≤ 115 msec, SA-VA ≤ 85 msec: AVRT (ORT).

**Corrected PPI-TCL interval.**
- PPI-TCL – (Post pacing AH interval – AH interval during SVT)
- PPI-TCL ≥ 110 msec: AVNRT. PPI-TCL ≤ 110 msec: AVRT (ORT).

**Predicted PPI-TCL interval.**
- PPI-TCL ≥ 110 msec: AVNRT.
- PPI-TCL ≤ 110 msec: AVRT (ORT).

**HA interval measurement: ΔHA (HA_{pacing} - HA_{SVT}).**
- HA_{pacing} > HA_{SVT} : AVNRT.
- HA_{pacing} < HA_{SVT} : AVRT (ORT).

slow conducting AP can present false positive result.
Step II. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AVRT vs. AVNRT.

Differential site VOP (RV apex vs. RV base).

In case of AVNRT, (PPI-TCL), PPI values from RV base are >30ms greater than those from RV apex as well as ΔVA values >20ms. However, in case of AVRT, (PPI-TCL), PPI, VA form RV base are similar with those from RV apex.

Single PVC with resetting SVT.

Corrected PPI-TCL value, and ΔVA value >110mms are compatible with AVNRT.

PPI-TCL cutoff value=125ms.

Increased the diagnostic sensitivity of AVRT.

PVC during His refractory period.

Slow conducting AP can present false positive result.
Step II. VOP (ventricular Overdrive Pacing) with entrainment of SVT: AVRT vs. AVNRT.

Transition Zone (TZ)
Progressive fusion → fixed fusion

AVRT: atrial advancement >15ms or fixed SA interval before the last beat of TZ
Step II. PVC on His refractory period with atrial activation patterns: AVRT vs. AVNRT.

PVC on His refractory period: perturbation of atrial activation, termination of SVT without atrial advancement indicates AVRT (ORT).
Step III. When the AVRT (ORT) is confirmed, Scrutinize septal AP: AVRT-AV vs. AVRT-NF/NV.

ΔAH (AH_{pacing} – AH_{PSVT}) using AOP can differentiate usual septal AP (ΔAH <20ms) from N/F or N/V tachycardia (ΔAH >40ms).
VOP

- When entrained
  - V-A-A-V
    - AT (JT)
      - PPI-TCL interval
      - SA-VA interval
      - VA linking
      - ΔVA interval
    - AVNRT
    - AVRT (ORT)
      - ΔAH interval
        - Paradoxical shortening of AH interval
        - Mahaim (NF/NV)

- When terminated
  - AOP and predicted PPI-TCL interval
  - Other adjuvant maneuvers
    - 1. PVC or PAC on His
    - 2. ParaHisian pacing
    - 3. RV apex and base pacing...
Conclusion

The stepwise approach will lead to a complete diagnosis as an efficient way. Overdrive pacing maneuver (ventricular and/or atrial) partakes a crucial role in these algorithm. We should understand pitfalls and mind that atypical AVNRT, septal AP (including slow conducting nature), and N/F, N/V pathway can confuse the EPS findings so that appropriate pacing maneuvers are mandatory for a correct diagnosis and successful catheter ablation.
Thank you for your attention